been driven through them. No proof of any such movement or of any volcanic action older in date than the Eocene, or Upper Cretaceous rocks, was obtained in this Expedition. So that we have here, apparently, an area where any subterranean movements which occurred never disturbed the conformable succession of deposits during that vast section of geological time from the Carboniferous (or even from the Silurian) up to the Eocene period. Whether the traces of terrestrial surfaces indicated by the plants and lignite beds of the Lower Cretaceous series, occurring as they do with marine strata below and above them, are to be regarded as marking oscillations of the crust, or as due merely to the gradual up-filling of the old sea-basin and its conversion into lagoons and terrestrial surfaces which were subsequently gently submerged again beneath the Middle and Upper Cretaceous seas, may be a question for discussion. It would seem that coincident with or subsequent to the pre-Miocene plication and upheaval, volcanic action began in the Western States. Dr. Newberry gives a drawing and a description of a singular basaltic rock called the Needles (Fig. 1) rising to a height of 1,700 feet above the Cretaceous floor of one of the tributary valleys of the San Juan, and regards this mass as having been intruded among the strata and as now left visible owing to its superior hardness, while the surrounding and overlying softer rocks have been washed away. But in his former Report in conjunction with Lieut. Ives, he showed the existence of a group of large extinct volcanoes in the San Francisco mountain group in Arizona, lying on the south side of the Colorado basin. The lava-streams are yet so fresh there that he supposes that the last eruption can hardly have taken place more than a comparatively few years ago. Considerably further to the east in New Mexico, San Mateo rises as another important extinct volcanic cone 11,000 or 12,000 feet high, whose most recent lavas are so fresh that "it is difficult to believe that they have been exposed to the action of the atmosphere even for so much as a hundred years." Dr. Newberry remarks that similar but smaller volcanic vents equally recent in appearance, but equally inactive now, are scattered over the entire area of the central tablelands from Mexico far up into the British possessions.

The author, who is an accomplished palæontologist as well as an active and gifted geologist, has added a valuable Appendix, in which he gives descriptions of the Carboniferous and Triassic fossils obtained by him in the course of the Expedition, and to which Mr. F. B. Meek[1] contributes an account of the Cretaceous fossils collected. It should be added, that besides the lithographic sketches the Report is enriched by some excellent plates of fossils.

ARCHIBALD GEIKIE

DEEP SEA MUDS[2]

II.

Peroxide of Manganese.

PEROXIDE of manganese occurs widely in ocean deposits, either as nodules, incrustations, or as depositions on the bottom itself. It has been found most frequently in the nodular form in the deep sea clays far from land. It also occurs in the organic oozes, when these contain much volcanic *débris*, or are near volcanic centres.

In shallow water, near some volcanic islands, it covers shells and pieces of coral or pumice with a light brown incrustation. It has been met with very sparingly, if at all, in shore deposits removed from volcanic centres.

In my preliminary report above referred to, I stated that further investigation might show that manganese nodules and depositions abound in these regions where we have much of the *débris* of augitic or heavy lavas.

A re examination of specimens since our return confirms this view. Wherever we have pumice containing much magnetite, olivine, augite, or hornblende, and these apparently undergoing decomposition and alteration, or where we have evidence of great showers of volcanic ash, there we find the manganese in greatest abundance. This correspondence between the distribution of the manganese and volcanic *débris* appears to me very significant of the origin of the former. I regard the manganese, as we find it, as one of the secondary products arising from the decomposition of volcanic minerals.

Manganese is as frequent as iron in lavas, being usually associated with it though in very much smaller amount. In magnetite and in some varieties of augite and hornblende the protoxide of iron is at times partially replaced by that of manganese.

In the manganese of these minerals and in the carbonic acid and oxygen of ocean waters we have the requisite conditions for the decomposition of the minerals, the solution of the manganese, and its subsequent deposition as a peroxide.

The carbonic acid converts the silicates of the protoxides of manganese, and the protoxides of manganese into carbonate of manganese, and thus prepares the way for oxidation by the oxygen of the water.

It is probable that the action of the carbonic acid is not apparent, and that the manganese is at once deposited as a high oxide if not as the peroxide. This theory is essentially the same as that which Bischof gives for manganese ores generally. I have laid a series of these manganese depositions on the table. An inspection of these and their localities will show that in the clays and oozes the depositions are nodular in form. If a section be made of one of these, a number of concentric layers will be observed arranged around a central nucleus—the same as in a urinary calculus. When the peroxide of manganese is removed by strong hydrochloric acid, there remains a clayey skeleton which still more strongly resembles a urinary calculus.

This skeleton contains crystals of olivine, quartz, augite, magnetite, or any other materials which were contained in the clay from which the nodule was taken. In the process of its deposition around a nucleus, the peroxide of manganese has inclosed and incorporated in the nodule the clay and crystals and other materials in which the nucleus was imbedded. The clayey skeleton thus varies with the clay or ooze in which it was formed. Those from a fine clay usually adhere well together; those from a globigerina ooze have an areolar appearance; those from a clay with many fine sandy particles usually fall to pieces. Mr. Buchanan informs me that the purest portions of these nodules, that is those portions made up of closely-packed concentric layers, contain from 30 to 34 per cent. of the peroxide.

Taking the nodule as a whole, it will of course contain very much less than this. The nucleus varies in each nodule, and that part of a nodule which is made up of concentric layers will vary with each locality and with the depth from which it comes. We may expect, therefore, that analysis will show considerable variations in the amount of alumina, silica, and metals, lime, &c., in the nodules from different stations. At some places in the Pacific the nodules show periods of deposition very distinctly. We have first a very compact nodule which may have a shark's tooth for a nucleus, and which appears to have been formed slowly. Then there would seem to have been a shower of ashes. After a time manganese was again deposited, inclosing in the nodule a layer of these ashes. The most frequent nucleus in the nodules is a piece of pumice or other volcanic fragment.

In deep sea clays, far from land, sharks' teeth, ear-bones of whales, and fragments of other bones are very often the nucleus around which the manganese is deposited. In one instance a piece of siliceous sponge forms the nucleus. In a globigerina ooze a portion of the deposit has apparently formed the nucleus. In these we have perfect casts of the foraminifera, but all the carbonate of lime has been removed. The volcanic fragments which have formed the nuclei of nodules appear frequently to have undergone peculiar alterations. For instance, obsidian is usually surrounded by beautiful agate bands.

When we found the bottom composed almost entirely of volcanic ashes, or so hard from other reasons that the sounding tube did not penetrate it, the manganese was deposited in layers over the bottom itself. Large pieces of this nature were taken several times.

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[1] Since this article was written, the announcement of Mr. Meek's death has reached this country. A more disastrous blow could not have been inflicted upon the progress of palæontology in the United States. It is much to be desired that amid the universal regret with which the death of this able palæontologist is received, some record shall be published of the services he has done. His numerous papers are scattered through so many publications (for he seems to have been ever at the call of any one who needed his assistance), that probably a comparatively small number even of palæontologists are aware of them all.

[2] "On the Distribution of Volcanic Débris over the Floor of the Ocean; its Character, Source, and some of the Products of its Disintegration and Decomposition," by Mr. John Murray. Read at the Royal Society, Edinburgh. Continued from p. 321.

The escape of carbonic acid through the floor of the ocean near volcanic islands may in these regions greatly accelerate the processes which end in the deposition of the peroxide of manganese, and account for the great abundance of it in some such localities where we found it.

Native Iron and Cosmic Dust.

While examining the deposits during the cruise I frequently observed among the magnetic particles from our deep sea clays small round black-coloured particles which were attracted by the magnet, and I found it difficult to account for the origin of these.

On our return home I entered into a more careful examination of the magnetic particles. By means of a magnet carefully covered with paper I extracted these particles from the deposits, from the pumice-stones, and from the manganese nodules of many regions. The great majority of these magnetic particles are magnetic iron ore and titaniferous iron, either in the form of crystals or as fine dust. In the clays and in the manganese nodules from stations far from land and in deep water there were again noticed many small round spheres among the magnetic particles.

On mentioning this to Prof. Geikie he suggested that I should try the method employed by Prof. Andrews, of Belfast, for detecting minute particles of native iron.

This process consists in moistening the magnetic particles, which have been extracted by means of the magnet, with an acid solution of sulphate of copper, when copper is at once deposited on any native particles which may be present. In this way I have detected native iron in many of our deposits, in the powdered portions of manganese nodules, and in pumice-stones.

Prof. Andrews tells me that there can be little doubt that the particles on which copper is deposited are native iron, as he has found that it is not deposited on nickel, and the chances of cobalt being present are very slight. Prof. Andrews warned me on the extreme precautions necessary in conducting these observations, that no iron from a hammer or other instrument should get at the specimen under observation.

It is true that all specimens of our deposits have been obtained by means of dredges and iron gear, and some of these particles may be from this source.

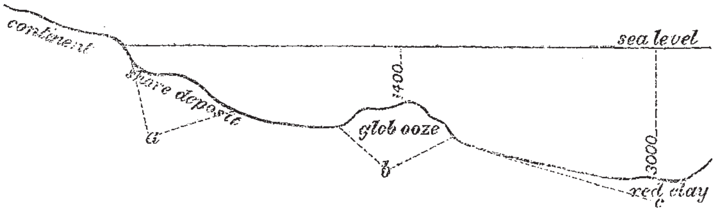
Many of the particles must have another origin. I have taken two of our manganese nodules, and washing them carefully, taking care to let no iron instrument come near them, have broken them by rapping them together. Then taking only the interior parts of these nodules I have pulverised them in a porcelain mortar. The magnetic particles were afterwards extracted by a magnet covered with paper. Now, placing these particles on a glass slide under the microscope, and adding the sulphate of copper solution, there was in a few moments a deposit of copper on several small perfect spherules, varying in size from the $\frac{1}{1000}$ to the $\frac{1}{300}$ of an inch in diameter. I have placed some of these spherules under the microscope and now show them to the Society. It will be noticed that on one the copper is not deposited all over the sphere, but in ramified spider-like lines. On the cut surface of a meteorite, from Prof. Sir Wyville Thomson's collection, which I also exhibit, the copper is precipitated in precisely the same manner as on the little sphere on the manganese nodule. Besides the spherules on which the copper is deposited, there are others generally of a larger size and dark colour. These are, so far as microscopic examination shows, quite like the particles on the mammilated outer surface of this Cape meteorite, also from Sir Wyville's collection.

These spherules have hitherto only been noticed in those deposits in deep water far from land, and where for many reasons we believe the rate of formation of deposits to be very slow.

They occur also only in those manganese nodules which come from the same deep sea clays or deposits far from land.

The particles of native iron found in pumice-stones are not numerous, and never take the form of spherules so far as observed. Some of these particles of native iron may then come from the dredge. Other particles come from the pumice and the volcanic materials. Prof. Andrews long since showed that minute particles of native iron existed in basalt and other rocks. And lastly, the spherules of which I have been speaking, appear to have a cosmic origin.

The reason for these spherules occurring only in deposits far from land and in deep water, may be more apparent by reference to the annexed diagram, which might represent a section from the west coast of South America out into the Pacific 500 miles. Along the shores of the continent, as at *a*, we have an accumulation of river and coast detritus. At *b* in depths from 1,400 to 2,200 fathoms we have a globigerina ooze mostly made up of surface shells. At *c*, in a depth of 2,300 to 3,000 fathoms, all the surface shells are removed from the bottom. No coast detritus reaches this area, and we find in the deposit pumice stones, some volcanic ashes, manganese nodules, sharks' teeth, and ear-bones of whales. It is only in areas like this that we find sharks' teeth and ear-bones of cetaceans in any numbers. Some of them from the same haul are deeply surrounded with manganese deposit, and contain little animal matter, while others have no deposit on them, and seem quite recent. These, and other facts which might be mentioned, all argue for an exceedingly slow rate of deposition. Now it is in these same areas that the spherules of native iron and other magnetic spherules are found, both in the deposits and in the manganese nodules from them.



Finding them in this situation favours the idea that they are of cosmic origin, for in such places they are least likely to be covered up or washed away. It is certainly difficult to understand why the spherules on which the copper is precipated have not become oxidised. If nickel be present in them, this may retard oxidation to some extent.

The manganese depositions in our ocean deposits are very different in structure and composition from any of the ores of manganese I have had an opportunity of examining, and the deposits of the deep sea far from land have not, so far as I know, any equivalents in the geological series of rocks.

All the subjects treated of in this paper are still under investigation, and at some future time I hope to present a much more detailed account.

These observations seem to me to give ground for the following conclusions :—

First.—That volcanic *débris*, either in the form of pumice stones, ashes, or ejected fragments, are universally distributed in ocean deposits.

Second.—That pumice stones are continually being carried into the sea by rivers and rains, and are constantly floating on the surface of the ocean far from land.

Third.—That the clayey matter in deposits far from land is principally derived from the decomposition of the feldspar in fragmental volcanic rocks, though in the trade wind region of the North Atlantic the dust of the Sahara contributes much material for clay.

Fourth.—That the red earth of Bermuda, Bahamas, Jamaica, and other limestone countries, is most probably originally derived from the decomposition of pumice stone, while these limestones were in the process of formation.

Fifth.—That the peroxide of manganese is probably a secondary product of the decomposition of the volcanic rocks and minerals present in the areas where the nodules of manganese are found.

Sixth.—That there are many minute particles of native iron in deposits far from land; that some of these particles are little spherules; that these last, as well as some other spherules which are magnetic, have probably a cosmic origin.

Seventh.—That the peroxide of manganese depositions in the deep sea are different in structure and composition from known ores of manganese.

Eighth.—That we do not appear to have equivalents of the rocks now forming in the deep sea far from land, in the geological series.

In conclusion, I have to acknowledge much assistance in these investigations from all my colleagues, especially my indebtedness to Sir Wyville Thomson and Mr. Buchanan.

Since my return I have received many hints from Profs. Tait, Geikie, Turner, Dr. Purves, Mr. Morrison, and other gentlemen.

In much of the mechanical work which an examination of these deposits has entailed, I have, both during the cruise and since my return, had the assistance of Frederick Pearcey.

OUR ASTRONOMICAL COLUMN

NEW COMET.—M. Stephan, Director of the Observatory at Marseilles, announces the discovery of a new comet by M. Borrelly on the morning of the 9th inst. It is described as bright, round, with a well-defined nucleus, and $3\frac{1}{2}$ minutes in diameter. The first complete observation gave for its position—

February 8 at 16h. 57m. 58s. M.T. at Marseilles.
Apparent Right Ascension ... ... 17h. 13m. 22·7s.
,, North Polar distance ... ... 91° 28′ 20″
Diurnal motion in R.A. + 1m. 44s. ; in N.P.D. − 3° 7′.

M. Borrelly was also the discoverer of the last unpredicted comet, on December 6, 1874, in which year six comets were observed ; in 1875 only two were observed, both known comets of short period ; in 1876 none.

THE OCCULTATION OF REGULUS ON FEBRUARY 26.—The occultation of a star of the first, or between the first and second magnitudes, is a sufficiently uncommon phenomenon to attract attention. Regulus will be occulted on the 26th instant while the moon is at a considerable altitude, and to facilitate the calculation of the times of immersion and emersion at any place in this country we will apply the very convenient method given by the late Prof. Littrow for distributing such predictions over a limited area.

Putting the latitude of the place = 50° + l, and expressing l in degrees, and the longitude from Greenwich = L, and expressing L in minutes of time, + if east, − if west, and founding the equations upon direct computations for Greenwich, Edinburgh, and Dublin, we find with the *Nautical Almanac* elements,

Time of Immersion = 12h. 47m·2 − $[0·0095]\,l$ + $[9·5191]\,L$
,, Emersion = 13h. 53m·5 − $[0·2188]\,l$ + $[9·3209]\,L$
Angle at Emersion from N. Point } = 232°·8 − $[0·185]\,l$ − $[9·468]\,L$

The quantities within brackets being logarithms and the resulting times for the meridian of Greenwich.

The following are the circumstances of the occultation at a few of our observatories ; Greenwich time throughout :—

	Immersion.		Emersion.		Angle at Emersion.
	h.	m.	h.	m.	°
Cambridge	12	45·1	13	49·9	229
Dublin	12	35·4	13	42·5	235
Edinburgh	12	36·9	13	40·9	227
Greenwich	12	45·7	13	51·0	231
Liverpool	12	39·7	13	45·2	231
Oxford	12	43·7	13	49·5	232

No other occultation of so bright a star, visible in this country, will take place until July 28, 1879, when Antares will be occulted.

Amongst the Chinese observations collected by the Jesuit missionary, Gaubil, are a number of occultations of Regulus, the earliest of which is dated March 16, A.D. 501. While referring to this star, we may mention a remarkable approximation of several planets near it, which is also recorded in the Chinese annals, and which, so far as we know, has never been examined. As interpreted by Gaubil, the observation runs thus :—

In B.C. 27, second year Ho-ping, in the tenth moon, between the 20th and last day of the moon, Saturn distant from Regulus 1° (Chinese measure), Jupiter to the north-west 1°, Mars to north-west 2°.

The Chinese commenced their year at the new moon immediately preceding the sun's entry into the sign Pisces, and their months were lunar. Accordingly in B.C. 27 the first moon commenced soon after midnight on February 10, Greenwich time, and the tenth moon on the evening of November 2 ; the time indicated by the Chinese record is therefore probably between November 23 and December 2. Perhaps some one may have the curiosity to examine this reported conjunction of Mars, Jupiter, Saturn, and Regulus. We can state positively that an occultation recorded about forty years earlier, observed under the same dynasty, Han, and at the same station, that of the Chinese court at Si-gnan-fou, in the province of Chen-sy, actually occurred, according to our latest tables, and at the hour recorded in the Chinese annals.

THE SOLAR ECLIPSE OF 1567, APRIL 9.—Prof. Grant, in his valuable "History of Physical Astronomy," remarks that "the earliest eclipse which was unequivocally asserted to have been annular was one which occurred in the year 1567." It was observed at Rome by Clavius, of Calendar celebrity, who has recorded that when the obscuration was greatest there still remained round the moon's limb a very narrow ring of the solar light. Kepler ("Ad Vitellionem") found from his tables the sun would have entirely covered the moon, and hence considered that the luminous ring, mentioned by Clavius, was in reality the *corona*, visible during total eclipses of the sun.

The elements of the eclipse of 1567 obtained upon a similar system of calculation to that applied to other modern solar eclipses in this column are as follow :—

Conjunction in R.A. 1567, April 8d. at 23h. 17m. 10s. G.M.T.

	°	′	″	
R.A.	26	30	57	
Moon's hourly motion in R.A. ...		33	8	
Sun's ,, ,, ,, ...		2	19	
Moon's declination	11	27	45	N.
Sun's ,, ...	10	58	57	N.
Moon's hourly motion in decl. ...		9	6	N.
Sun's ,, ,, ,, ...		0	52	N.
Moon's horizontal parallax		57	36	
Sun's ,, ,, ...		0	9	
Moon's true semi-diameter		15	54·0	
Sun's ,, ,, ...		15	41·7	

The sidereal time at Greenwich mean noon, April 9, was 1h. 47m. 8s. If with the above elements we make a direct calculation of the circumstances of the eclipse at Rome we find a very great eclipse little short of totality ; began at 10h. 41m. 0s A.M., ended at 1h. 42m. 23s. P.M. mean times at Rome, magnitude 0·9972, so that the breadth of the crescent was about $2\frac{1}{2}$ seconds. The eclipse would be total for a few seconds on the central line in this longitude, the augmented semi-diameter of the moon exceeding the sun's semi-diameter only 1″·5 ; but our result as it stands may very well explain the words of Clavius, the extremely narrow crescent of the solar disc still remaining, added to the probable visibility of the brighter part of the *corona*, giving to the naked eye the appearance of a narrow uniform ring of light.

NEW MINOR PLANET.—No. 172 of the group of small planets was detected by M. Borrelly at Marseilles on the 5th inst. ; at 12h. 8m. its R.A. was 10h. 35m. 36s., N.P.D. 80° 30′·9, twelfth magnitude. On the following night at 9h. 58m. its R.A. was 10h. 34m. 46s., N.P.D. 80° 29′·3.

METEOROLOGICAL NOTES

METEOROLOGY OF THE LIBYAN DESERT.—A second volume of Gerhard Rohlfs' great expedition into the Libyan desert has been recently published at Cassel, under the editorship of Dr.